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CENTRAL FAX CENTER****JUN 29 2007****IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Lowell L. Winger et al.

Assignee: LSI Corporation

Title: METHOD AND/OR CIRCUIT FOR BINARY ARITHMETIC DECODING  
DECISIONS BEFORE TERMINATION

Serial No.: 10/624,253

Filed: July 22, 2003

Examiner: Rao, A.

Art Unit: 2621

Attorney Docket No.: 03-0781 / 1496.00317

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Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**DECLARATION OF LOWELL L. WINGER AND ERIC C. PEARSON  
PURSUANT TO 37 C.F.R. S 1.131**

We, Lowell L. Winger and Eric C. Pearson, hereby declare as follows:

1. We were employed by LSI Logic Corporation at the time the above referenced patent application was prepared and filed.

2. We understand that in one embodiment, the presently claimed invention concerns:

A method for decoding a bitstream, comprising the steps of:

(A) generating a first signal and a second signal by parsing a common slice in said bitstream;

(B) generating a third signal by entropy decoding said first signal; and

(C) generating a video signal by combining said second signal and said third signal.

3. We understand that in another embodiment, the presently claimed invention concerns:

An apparatus comprising:

a parser configured to generate a first signal and a second signal by parsing a common slice in a bitstream;

a decoder configured to generate a third signal by entropy decoding said first signal; and

a circuit configured to generate a video signal by combining said second signal and said third signal.

4. We understand that in still another embodiment, the presently claimed invention concerns:

An apparatus comprising:

means for generating a first signal and a second signal by parsing a common slice in a bitstream;

means for generating a third signal by entropy decoding said first signal; and

means for generating a video signal by combining said second signal and said third signal.

5. Prior to May 28, 2003, we conceived the invention claimed in the above-identified patent application as shown by pages 1-4 of the LSI Invention Disclosure Form, Diagrams #1 and #2 and Figures #3 and #4, which are attached as Exhibit A. The redacted date of conception on page 1 of Exhibit A indicated a date which was before May 28, 2003.
6. The redacted notations in the lower lefthand corner on pages 1 through 4 in Exhibit A show an original document date which was before May 28, 2003.
7. In our opinion, the attached Exhibit A corresponding to the LSI Corporation Invention Disclosure Form, Diagrams #1 and #2 and Figures #3 and #4 describe the claimed invention and convey information sufficient to enable one skilled in the relevant art to make and use the claimed invention. For example, Diagram #1, Diagram #2, Figure #3 and Figure #4 correspond to FIGS. 2-5, respectively, of the present application.
8. The LSI Corporation Invention Disclosure Form and accompanying diagrams and figures were submitted to LSI's legal department prior to May 28, 2003.
9. On June 4, 2003 Applicants' representative's law firm was engaged to prepare the application for patent filed July 22, 2003. A redacted copy of an e-mail dated June 4, 2003 from LSI Corporation's Corporate Counsel engaging Applicants' representative's law firm is attached as Exhibit B.

10. Applicants' representative's law firm prepared a first draft of the present application, which was sent to us on July 10, 2003. A copy of the cover letter for the first draft dated July 10, 2003 is attached as Exhibit C.
11. On July 18, 2003, we sent comments on the first draft to Applicants' representative's law firm. A copy of the fax cover sheet for the comments that we sent to Applicants' representative's law firm dated July 18, 2003 is attached as Exhibit D.
12. On July 21, 2003 Applicants' representative's law firm sent a final draft to us. A copy of a cover letter, dated July 21, 2003, for the final draft of the above-referenced application that was sent to us is attached as Exhibit E.
13. The patent application was filed in the United States Patent and Trademark Office on July 22, 2003 as indicated by a letter from Applicants' representative's law firm attached as Exhibit F.

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JUN 29 2007

14. We declare that all statements made herein of our knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or patents issued therefrom.

Date: \_\_\_\_\_

\_\_\_\_\_  
Lowell L. Winger

Date: June 28/07

  
Eric C. Pearson

14. We declare that all statements made herein of our knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or patents issued therefrom.

Date: June 29, 2007

Lowell L. Winger  
Lowell L. Winger

Date: \_\_\_\_\_

\_\_\_\_\_  
Eric C. Pearson

# LSI LOGIC CONFIDENTIAL

Patent Docket Number - 03-0781 - Generic method for binary arithmetic decoding decisions before termination  
 - Invention Disclosure Acknowledgement - Lowell Winger - lwinger@lsil.com

Title: Generic method for binary arithmetic decoding decisions before termination

## Inventor(s)

Name: Eric Pearson  
 Email: epearson  
 Phone: [REDACTED]

Dates: [REDACTED]  
 Conception: [REDACTED]  
 Reduction to practice: [REDACTED]

Disclosure of invention: [REDACTED]

Sale or offer for sale of invention: [REDACTED]

Use of invention: [REDACTED]

## Background of invention

Existing problems

A very recent addition to the proposed H.264 video coding standard that was made just before the completion of the standard was the inclusion of an L\_PCM macroblock coding mode.

While video compression attempts to compress every macroblock of a video sequence, there is no guarantee that individual macroblocks will in fact be compressed. In practice, while noise will in fact be expanded to some extent by compression techniques.

L\_PCM mode provides a coding mode that guarantees a limit on this expansion. One point of value for this mode is that it provides a mechanism for an encoder such that it can potentially more easily produce a bitstream that guarantees a maximum number of bits per macroblock, thereby potentially enabling simpler decoding hardware that takes advantage of this guaranteed limitation.

L\_PCM mode outputs the actual values of the pixels contained in a 16x16 macroblock, rather than attempting to compress this information, and as such is a type of "fail safe".

## ATTORNEY-CLIENT PRIVILEGED COMMUNICATION

Page 1 of 4

We believe myself (ourselves) to be the first and original inventor(s) of this invention, which was developed during the course of employment. We submit this invention disclosure in confidence to attorneys of the LSI Logic IP Law Dept, for the purpose of obtaining a legal opinion and/or advice as to availability of patent, trade secret, and/or copyright protection related to the material contained within.

Inventor(s)

Date

Witnesses who have read and understood the invention

Witness #1

Date

Witness #2

Date



# LSI LOGIC CONFIDENTIAL

Patent Docket Number - 03-0781 - Generic method for binary arithmetic decoding decisions before termination

- Invention Disclosure Acknowledgement - Lowell Winger - lwinger@lsi.com

mode that bounds the size of a macroblock in the compressed video bitstream.

While PCM coding is a method that has been well understood for decades, H.264 is the first instance where an L\_PCM macroblock mode is incorporated into a video codec that switches between PCM and non-PCM coding modes.

The problem that this invention is solving is the provision of a mechanism to by-pass the context adaptive arithmetic entropy encoding (CABAC) stage for L\_PCM encoded macroblocks. Since the idea behind L\_PCM mode is to avoid all compression, we would like a method that effectively bypasses the entropy encoding stage in the H.264 codec for bits that belonged to an L\_PCM macroblock.

Existing solutions to these problems

The existing solution to this problem existed in versions of the H.264 standard prior to and including the document JVT-G050.doc that was submitted to both ITU-T and MPEG as the final text for international standardization of the H.264/AVC standard.

In this solution when CABAC coding is terminated it is specified that the next bit to be decoded MUST be the syntax element `rspp_stop_one_bit`.

To quote from subclause 9.3.3.2.4 of the JVT-G050.doc:

"If `codiOffset` is larger than or equal to `codiRange`, a value of 1 is assigned to `tinVal`, no renormalization is carried out and CABAC decoding is terminated. In such a case, the last bit inserted in register `codiOffset` is `rspp_stop_one_bit`."

Disadvantages of existing solutions

The disadvantage of the existing approach is that it lacks the ability to terminate CABAC encoding prior to sending an L\_PCM macroblock unless the slice is also terminated at the same time. For an L\_PCM macroblock the next bit decoded after terminating CABAC decoding could be either the syntax element `psp_alignment_zero_bit`, or the first bit of a `psp_byte_syntax` element.

The existing solution disallows CABAC encoded slices that contain other types of macroblocks

## ATTORNEY-CLIENT PRIVILEGED COMMUNICATION

Page 2 of 4

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Invention(s)

Date

Witnesses who have read and understood the invention

Witness #1: Date

Witness #2: Date





# LSI LOGIC CONFIDENTIAL

Patent Docket Number - 03-0781 - Generic method for binary arithmetic decoding decisions before termination

- Invention Disclosure Acknowledgement - Lowell Winger - lwinger@lsil.com

prior to an L\_PCM macroblock. To use L\_PCM mode with the existing solution the current slice must first be terminated, and then a new slice begun with an L\_PCM macroblock.

There are typically many bits of overhead associated with terminating the existing slice and beginning a new slice (a new slice header must be transmitted), so for broadcast applications in which the overhead bits required by many small slices are not required for error resilience (as is the case for internet streaming applications for example) the existing approach carries an undesirable penalty.

## Description of invention

### Details of invention

The new invention is a generalization of the existing method in which up to three different syntax elements may follow a CABAC decoding termination.

This new invention may require marginally more complexity, since the syntax element that follows a CABAC termination is no longer always known without additional contextual information.

The new method has been submitted to the MPEG and ITU bodies and is expected to be adopted into the final MPEG4-AVC and H.264 standards, respectively.

To quote from subclause 9.3.3.2.4 of the text that specifies the use of the new invention:

"If codiOffset is larger than or equal to codiRange, a value of 1 is assigned to binVal, no renormalization is carried out and CABAC decoding is terminated.

Note - When decoding end\_of\_slice\_flag, the last bit inserted in register codiOffset is rbsp\_stop\_one\_bit. When decoding the bin of mb\_type that specifies the L\_PCM macroblock type, the last bit inserted in the register codiOffset is either a pcm\_alignment\_zero\_bit, or the first bit of the first pcm\_byte."

### Features of invention

The new invention requires that a decoder be capable of parsing one of three potential syntax elements following a CABAC termination.

rbsp\_stop\_one\_bit, pcm\_alignment\_zero\_bit, or pcm\_byte

## ATTORNEY-CLIENT PRIVILEGED COMMUNICATION

Page 3 of 4

I/We believe myself (ourselves) to be the first and original inventor(s) of this invention, which was developed during the course of employment. I/We submit this invention disclosure in confidence to attorneys of the LSI Logic IP Law Dept. for the purpose of obtaining a legal opinion and/or advice as to availability of patent, trade secret, and/or copyright protection related to the material contained within.

Inventor(s)

Date

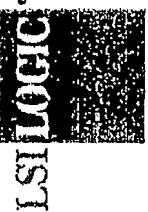
Witness who have read and understood the invention

Witness #1

Date

Witness #2

Date



# LSI LOGIC CONFIDENTIAL

Patent Docket Number - 03-0731 - Generic method for binary

arithmetic decoding decisions before termination

- Invention Disclosure Acknowledgement - Lowell Winger -

lwinger@lsil.com

The new invention enables a valid syntax that can be produced by an encoder in order to produce a bitstream with slices containing L\_PCM macroblocks in slices that switch from non-L\_PCM macroblocks to L\_PCM macroblocks (in macroblock scan order).

## Advantages of invention

The primary advantage of the invention is that more efficiently compressed bitstreams containing L\_PCM macroblocks can be produced.

The substantial practical advantage of the invention is that since it is expected to be incorporated in the H.264/MPEG-AVC standard, no decoder may be compliant to the Main Profile of the standard without supporting this invention.

## Alternate ways to make or use invention

This invention is very specific to H.264/MPEG-AVC encoders, decoders, and transcoders, but could potentially be used in future video standards that incorporate the two necessary elements of an arithmetic entropy coder and an PCM macroblock mode.

## Other

## Prior Art:

## Third party issues

## ATTORNEY-CLIENT PRIVILEGED COMMUNICATION

Page 4 of 4

I/we believe myself (ourselves) to be the first and original inventor(s) of this invention, which was developed during the course of employment. I/we submit this invention disclosure in confidence to attorneys of the LSI Logic IP Law Dept. for the purpose of obtaining a legal opinion and/or advice as to availability of patent, trade secret, and/or copyright protection related to the material contained within.

## Inventor(s)

## Date

Witnesses who have read and understood the invention

Witness #1

Date

Witness #2

Date

DIAGRAM #1 (Encoder of Video/Audio/and-or Image data) [typical usage is for the H.264/MPEG4-AVC video encoding standard]:

Notes:

- 1) for H.264/MPEG4-AVC the choice between arithmetic entropy coded (AC) and PCM data is made on each macroblock worth of data
- 2) if the switch between AC and PCM data were on the slice or picture level, there would be no need for the current invention in the H.264/MPEG4-AVC standard as the AC data would always be properly terminated through the pre-existing algorithm for end-of-slice termination in the standard, allowing a clean and error-free transition to PCM data for the following blocks of data
- 3) This invention exists in the Arithmetic Entropy Coding (AC) block of both the encoder and the decoder, and is a new method for determining when to renormalize the arithmetic coding (before termination) when [en/de]coding the end-of-slice-flag and the bin-indicating-I\_PCM mode.
- 4) In the new method the conditions for performing renormalization and setting the current binVal in the arithmetic [en/de]coder are identical for termination following EITHER the end-of-slice-flag OR the bin-indicating-I\_PCM mode. In the old method, binVal could be set to 1 and renormalization NOT performed ONLY if the last bit inserted in register codOffset was rbsp\_stop\_one\_bit -- ie. only for [en/de]coding the end-of-slice flag. That is, for the old method binVal could never be set to 0 and renormalization performed for [en/de]coding the bin-indicating-I\_PCM mode. ie. The old method lacked a correct termination of the AC engine for [en/de]coding the bin-indicating-I\_PCM mode, preventing the possibility of macroblock-level switching in the middle of a slice (a group of macroblocks composing a portion of one video frame or field) of data from arithmetic coded macroblocks to PCM coded macroblocks.

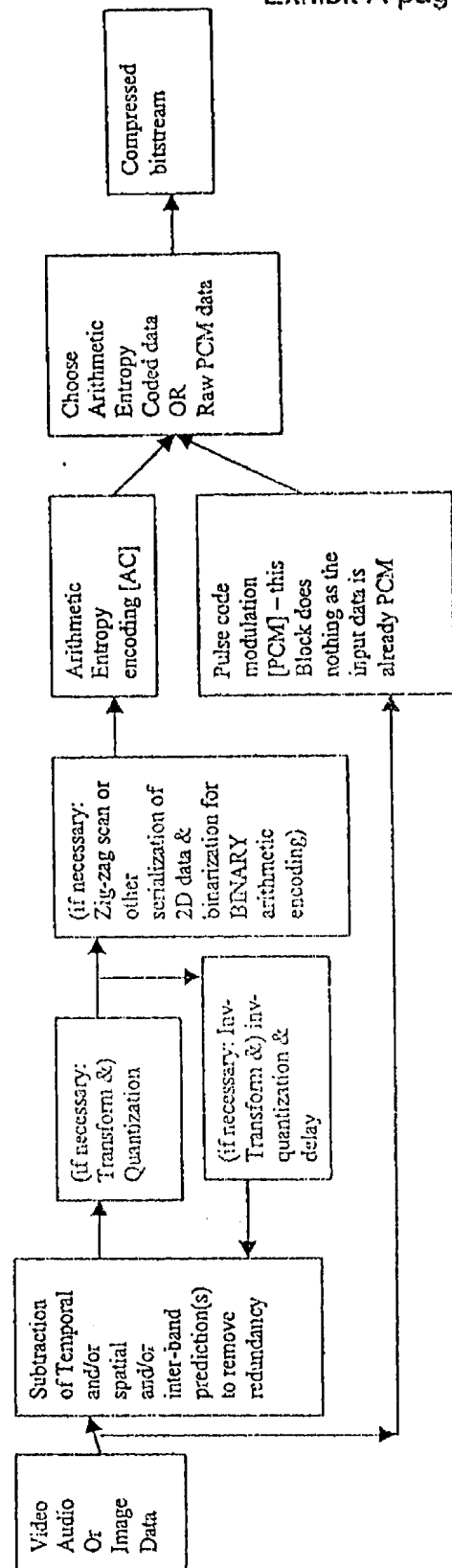


DIAGRAM #2 (Decoder of Video/Audio/and-or Image data) [typical usage is for the H.264/MPEG4-AVC video encoding standard]:

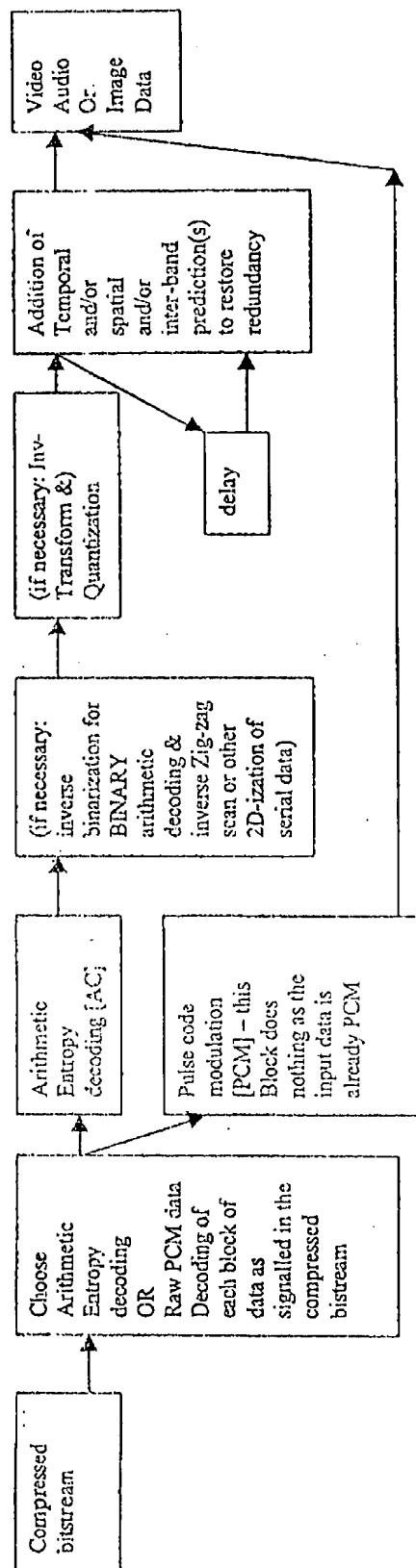


Figure #3: simplified block diagram of a BINARY arithmetic coding engine  
 1) note, this invention is not necessarily limited to use only for binary arithmetic encoding, but could also apply to non-binary arithmetic encoding; however, this would require that binVal be replaced with symbolVal and various other changes in Figure #3 and Figure #4 as the internal working of a non-binary arithmetic coding engine differs substantially from a binary arithmetic coding engine

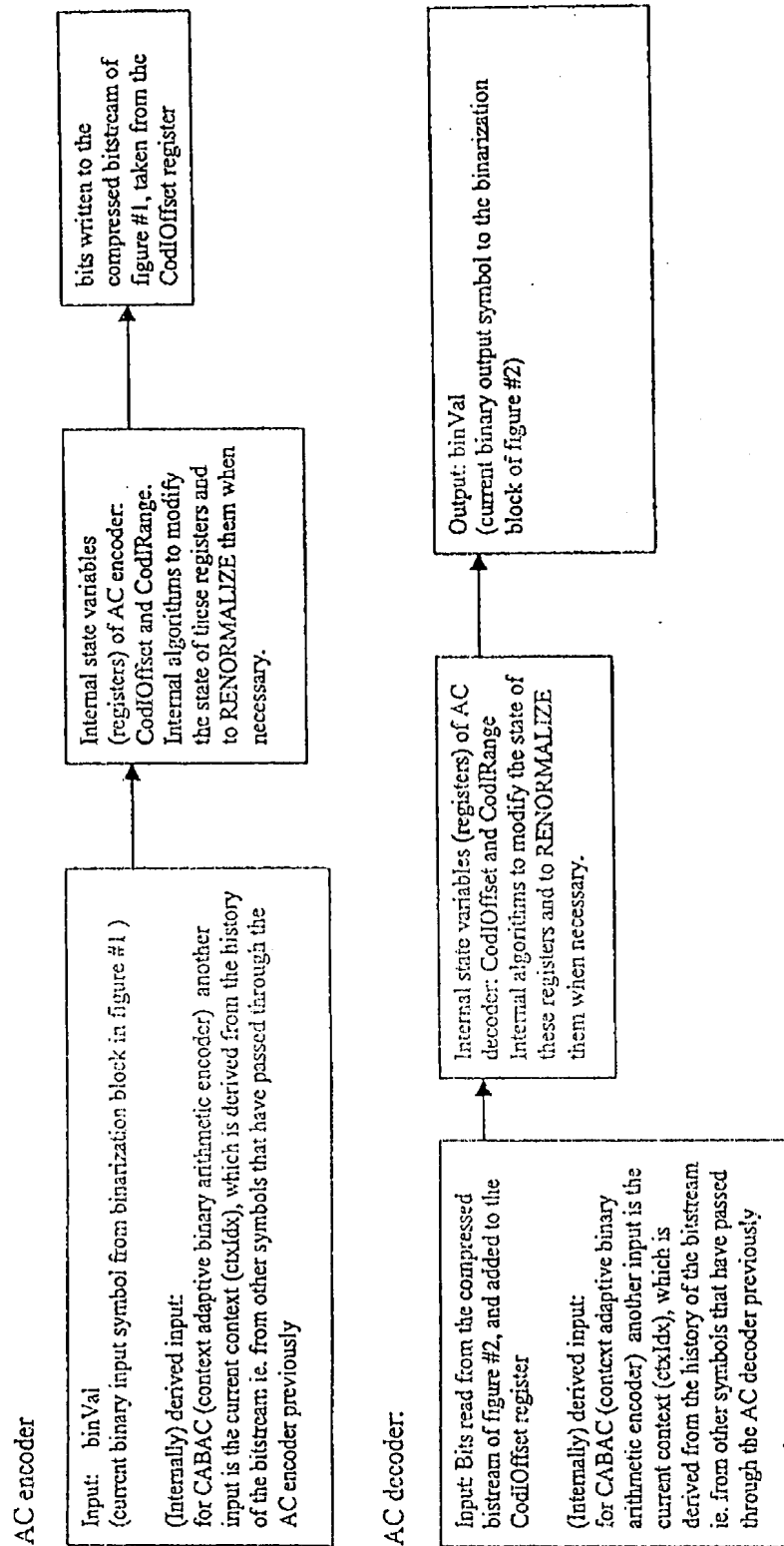
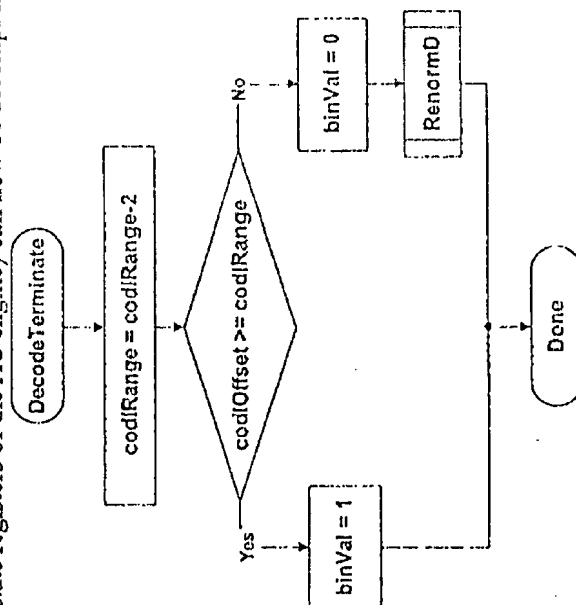


Figure #4: Flowchart of decoding a decision before termination that is an algorithm internal to the arithmetic coding engine. This algorithm is invoked when [en/de]coding the end-of-slice-flag OR the bin-indicating-I\_PCM mode. This flowchart is for the arithmetic decoder only, as this is the standardized portion of the codec for H.264/MPEG4-AVC. The internal state register `codIRange` is first decremented by 2, then compared with the `codIOffset` register. Depending on the result of the comparison the binary symbol `binVal` is output with either a value 0 (after which renormalization of the internal state of the arithmetic coding engine must occur) or a value 1. Note that it is in the method of operation of this DecodeTerminate algorithm that the current invention differs from prior art: namely prior art permitted only the 'No' branch to be taken for decoding of the bin-indicating-I\_PCM mode. The statement that mandated this behaviour in the prior art was 'If `codIOffset` is larger than or equal to `codIRange`, a value of 1 is assigned to `binVal`, no renormalization is carried out and CABAC decoding is terminated. IN SUCH A CASE, THE LAST BIT INSERTED IN REGISTER CODIOFFSET IS RBSP\_STOP\_ONE\_BIT.' In the new invention the only technical change to the text of the H.264/MPEG4-AVC standard text is the removal of the capitalized text from section 9.3.3.2.4. ie. The addition of an optional note to the standard does not affect what is required for conformance to the standard. The effect of the removal of the capitalized statement is that correct termination (ie. decoding of the `binVal` symbol and renormalization of the internal state registers of the AC engine) can now be accomplished when decoding the bin-indicating-I\_PCM mode



Notes: the RenormD block is an algorithm to change the values of codlOffset and codlRange dependent only upon their current values, and additional bits that may be added to the codlOffset register (read from the bistream) during the operation of the RenormD algorithm.

Exhibit B page 1 of 1

Subj: Patent 03-0781 - - AUTHORIZATION - 4P-USP - Preparation and filing of original U.S. patent application in USPTO - Max. amt. = \$[REDACTED] - Due on [REDACTED] - Generic method for binary arithmetic decoding decisions before termination

Date: 6/4/2003 5:18:59 PM Eastern Daylight Time

From: mkashyap@lsil.com

To: chriscpm2@aol.com

File: [REDACTED]  
(TCP/IP): < 1 minute

Sent from the Internet ([Details](#))

Attached files :

1. [REDACTED]
2. [REDACTED]
3. [REDACTED]

AUTHORIZATION - 4P-USP - Preparation and filing of original U.S. patent application in USPTO - Max. amt. = \$[REDACTED] - Due on [REDACTED]

This is an authorization. The amount authorized for this task is the maximum amount to be spent on completing the task. Upon completion of the task, please bill us for the lesser of (1) the actual time spent on the task and (2) the maximum amount authorized. We expect to be billed for the actual time spent on the task. Please do NOT bill us for the maximum amount authorized unless the actual time spent equals or exceeds the maximum authorized amount.

Intellectual Property Law web site : [REDACTED] (LSI Internal use only)

Thursday, June 05, 2003 America Online: Chriscpm2



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JUN 29 2007

CHRISTOPHER P. MAIORANA  
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PATENTS, TRADEMARKS  
& COPYRIGHTS

July 10, 2003

VIA E-MAIL

Lowell L. Winger  
Eric C. Pearson  
LSI Logic Corporation of Canada  
97 Randall Drive  
Waterloo, ON, Canada N2V 1C5

Re: United States Patent Application Entitled:  
METHOD AND/OR CIRCUIT FOR BINARY ARITHMETIC DECODING  
DECISIONS BEFORE TERMINATION  
LSI Reference No.: 03-0781  
LSI Attorney: Leo Peters  
Our Reference No.: 1496.00317

Dear Lowell and Eric:

Enclosed is a first draft of a patent application directed to the above-referenced invention. The patent application is based upon technical information found in the invention disclosure you provided.

In reviewing the application, please be sure to consider the following:

1. The application should provide sufficient information to teach one of ordinary skill in the art how to make and use the invention. As a minimum threshold, consider if you were reading the disclosure for the first time without your previous knowledge of the application. You should be able to make and use the invention without undue experimentation. While some experimentation may be required, if undue experimentation would be needed to practice the invention, not enough information is provided in the application. Please call me if you have any questions regarding this standard.
2. The application should be technically accurate.
3. The closest references that I am aware of will be cited with the application. If you are aware of other references, either articles or patents, which disclose pertinent information not mentioned in the application or disclosure, please advise me and provide me with a copy of such materials.

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JUN 29 2007

Lowell L. Winger  
Eric C. Pearson  
July 10, 2003  
Page 2

4. If LSI proprietary terms are used, please point them out to me.
5. The patent application should disclose the best mode of carrying out the invention. In other words, if you are aware of a better way of practicing the invention that is not included in the draft, please let me know.

Please appreciate that this is the first draft of the patent application for the above-referenced invention. It is expected that this draft may be modified based upon your input. With this in mind, please make whatever additions, deletions, corrections or comments you desire right on the enclosed copy of the draft and send or fax the corrected draft to me. If you have questions regarding the review of this draft, or feel it would save you time in review, please feel free to call me for a discussion. Your prompt attention to this matter will be appreciated.

Very truly yours,

CHRISTOPHER P. MAIORANA, P.C.

Christopher P. Maiorana

CPM/indb  
Enclosure

cc: Manu Kashyap (w/enclosure via e-mail)

G:\V.SI149200631\ADRAFTAPP.1st.wpd

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## LSI LOGIC CANADA CORPORATION

97 Randall Drive, Waterloo, Ontario N2V 1C5  
Telephone: (519) 725-9797, Fax: (519) 725-5345

### Fax Cover

To: Christopher Maiorana

Fax: 9-1-586-498-0673

From: ERIC PEARSON

Date: July 14/03

No. of Pages: 10 (Including this one) If you do not receive the correct number of pages, please call.

Subject: Review of Draft for 15T 03-0781  
1496.00317

### Notes:

Fig #1, Pgs 2, 3, 5, 6, 7, 8, 9, 12

Pls call if you have any questions  
1-519-725-9797 x311

Eric Pearson

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JUN 29 2007

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PATENTS, TRADEMARKS  
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July 21, 2003

VIA E-MAIL

Lowell L. Winger  
Eric C. Pearson  
LSI Logic Corporation of Canada  
97 Randall Drive  
Waterloo, ON, Canada N2V 1C5

Re: United States Patent Application Entitled:  
METHOD AND/OR CIRCUIT FOR BINARY ARITHMETIC DECODING  
DECISIONS BEFORE TERMINATION  
LSI Reference No.: 03-0781  
Our Reference No.: 1496.00317

Dear Lowell and Eric:

Enclosed please find a final, revised copy of the patent application referenced above along with an Assignment and Declaration with Power of Attorney.

After reviewing the application, please sign and date two (2) copies of the Formal Papers in blue ink and return them to me via facsimile. Please forward the original documents via regular mail at your earliest opportunity.

Please feel free to keep the copy of the application and drawings for your records.

If you have any questions, please do not hesitate to call.

Very truly yours,

CHRISTOPHER P. MAIORANA, P.C.

Christopher P. Maiorana

CPM/mbd  
Enclosures

cc: Manu Kashyap (via e-mail w/enclosures)  
G:\LSI\496\00317\FINAL.wpd

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July 22, 2003

VIA E-MAIL

Manu Kashyap  
Intellectual Property Law Department  
LSI Logic Corporation  
M/S D-106  
1621 Barber Lane  
Milpitas, CA 95035

Re: United States Patent Application Entitled:  
METHOD AND/OR CIRCUIT FOR BINARY ARITHMETIC DECODING  
DECISIONS BEFORE TERMINATION  
Your Reference No.: 03-0781  
Our Reference No.: 1496.00317

Dear Manu:

The above identified patent application was filed with the United States Patent and Trademark Office on July 22, 2003 with formal drawings.

The original assignment and declaration were signed on July 21, 2003 by all the inventors.

If you have any questions, please do not hesitate to call.

Very truly yours,

CHRISTOPHER P. MAIORANA, P.C.

Christopher P. Maiorana

CPM/mdb  
Enclosures (via e-mail)

G:\SI1496\00317\FILED.LTR